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13. ABSTRACT (Maximum 200 words)

This research summarizes research on scattering from a wedge-on-a-plane geometry as a means to better understand the effects of such a perturbation on the propagation of electromagnetic waves over such a surface. The method of solution is the method of ordered multiple interactions (MOMI) and it was found that only two iterations were required to obtain sufficient accuracy for scattering into the entire upper half-space. Significant results from the study were as follows. When the tip of wedge has a radius of curvature less than about one em wavelength, the wedge tip may be considered to be perfectly sharp. The sharp tip causes an induced current that extends well beyond the support of the incident field for TM polarization particularly. The effect of this on the scattered field is most pronounced in the low grazing angle backscatter direction. The dominant scattering mechanism in the low grazing angle backscattering direction is interference between the tip diffracted field and the tip diffracted-planar reflected field. In this intereference region, the ratio of TE to TM scattered powers can approach 0 dB because peaks of the TE cattering correspond to the minima of the TM scattering pattern. This intereference pattern appeared to persist when random roughness was added to the surface.The forward scattering is dominated by the flat surface specularly field, the field that is specularly reflected from the sloping surface of wedge nearest to the source, and tip diffraction into the forward direction. The resulting intereference in the forward direction gives rise to "shoulders" in the specularly reflected field pattern.

14. SUBJECT TERMS
wedge scattering, tip diffraction, wedge-on-a-plane scattering, multiple scattering, numerical methods, forward scattering

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FINAL PROGRESS REPORT

The purpose of this research was to study the particular effects of an isolated, but major surface perturbation on the scattering of electromagnetic waves with the intent of gaining insight into the impact of such shapes on propagation over the undisturbed planar surface. The particular shape considered was that of a wedge-shaped protrusion on an otherwise perfectly flat conducting plane. The join of the wedge to the flat surface was made to be continuous through the second derivative in height and the tip of the wedge was rounded but with a variable radius of curvature. With the ability to change the tip radius of curvature, it was possible to study the transition from shadow boundary diffraction to sharp tip diffraction. Three different width wedges were studied to determine the dominant scattering mechanisms and any difficulties in calculating the scattering from such an arrangement.

There were a number of important results from this study, and they are listed below.

1. The method of ordered multiple interactions (MOMI) was found to be a robust method to calculate the scattering from this geometry with the sharp wedge tip causing no appreciable problems other than the need to use a denser sampling of the induced surface current.
2. Two (2) iterations using MOMI were found to be sufficient for obtaining an accurate scattered field in all bistatic directions.
3. Stable results were found when the total length of the planar surface was taken to be in excess of approximately four (4) times the beamwidth of the incident field pattern (as measured on the surface).
4. When the tip of the wedge closely approximated that of a sharp tip, i.e., less that 0.8 electromagnetic wavelengths radius of curvature, the current induced on the planar part of the surface had a very slow decay away from the illuminated region for TM (or vertical) polarization. Multiple scattering of the tip-diffracted incident fields back down onto the planar part of the surface was the cause of this phenomenon. However, this extended support of the induced current seemed to affect the scattered field in the extreme low grazing angle backscatter regime only.
5. It was found that for both TE and TM polarizations, the wedge behaved as a perfectly sharp wedge when the radius of curvature of the wedge tip was less than 0.8 electromagnetic wavelengths.
6. When the tip radius of curvature was in the range of one to four electromagnetic wavelengths, the wedge appeared to behave as a much weaker source of diffracted energy. That is, the diffraction from the more smoothly curved tip was much weaker that from a sharp tip. In addition, the current in the vicinity of the tip for this degree of smoothing did not appear to replicate that of a shadow boundary.
7. The most dominant mechanism in the low grazing angle backscattering direction was the interference between the field that is diffracted from the tip and back to the observer and the filed that is tip diffracted and then reflected by the planar surface. This interference pattern had very pronounced peaks and nulls which became attenuated in amplitude and essentially went away when the tip of the wedge was rounded. An interesting observation here was that the peaks in the interference pattern from TE polarization corresponded to the nulls in the interference pattern for TM polarization! Consequently, the ratio of the TE low grazing angle backscattering to that of the TM could go as high as 0 dB. The high levels of backscattering ratios have been observed with ocean scattering, but there has been no explanation for the source of the scattering.
8. The interference effect in the forward direction is much less pronounced because of the strength of the specularly scattered field. However, the specularly reflected field does exhibit "shoulders" or "sidelobes" due to the interference between it and the tip diffracted field.
9. The inclusion of surface roughness at the level of koh = 1.9, where ko is the electromagnetic wavenumber and h is the rms roughness height, did not alter the above noted results very much although rougher surfaces will no doubt attenuate the interference phenomena in both the forward and backward directions.